RUSSIAN FEDERATION

(19) RU (11) 2 274 939 (13) C2

(51) Int. Cl.
H02M 1/10 (2006.01)

FEDERAL SERVICE
FOR INTELLECTUAL PROPERTY,
PATENTS AND TRADEMARKS

(12) ABSTRACT OF INVENTION

(21), (22) Application: 2004104345/09, 08.02.2002

(24) Effective date for property rights: 08.02.2002

(30) Priority: 31.10.2001 US 60/335,785

(43) Application published: 27.06.2005

(45) Date of publication: 20.04.2006 Bull. 11

(85) Commencement of national phase: 12.02.2004

(86) PCT application:
US 02/03542 (08.02.2002)

(87) PCT publication:
WO 03/038981 (08.05.2003)

Mail address:
129010, Moskva, ul. B. Spasskaja, 25, str.3,
OOO "Juridicheskaja firma Gorodisskij i Partnery", pat.pov. Ju.D.Kuznetsovu, reg.№ 595

(72) Inventor(s):
MAKDONAL'D Gilbert (US),
SMIT Skott (US)

(73) Proprietor(s):
MOBILITI EhLEKTRONIKS INK. (US)

RU 2274939 C2

RU 2274939 C2

(54) Title: DUAL INPUT AC AND DC POWER SUPPLY HAVING A PROGRAMMABLE DC OUTPUT UTILIZING A SECONDARY BUCK CONVERTER

(57) Abstract: A dual input AC-to-DC power converter (10) having dual inputs (12, 14) adapted to receive both an AC and DC input and provide a selectable DC voltage output (16) and a second DC output (18). The dual input AC-to-DC power converter (10) comprises a power converter circuit (20) having an AC-to-DC converter (22), a DC-to-DC booster converter (24), a feedback circuit (26), a filter circuit (25) and a DC-to-DC buck converter (28). Advantageously, the power converter (10) resolves many system management problems associated with carrying the different interface components necessary to power a wide variety of mobile products from either an AC or DC power supply. In addition, the power converter (10) also includes dual output voltage terminals (16/18) to allow for multiple mobile devices with varying power requirements to be powered simultaneously by a single converter. The above constitutes the technical effect. 25 claims. 3 figures [6 drawings].

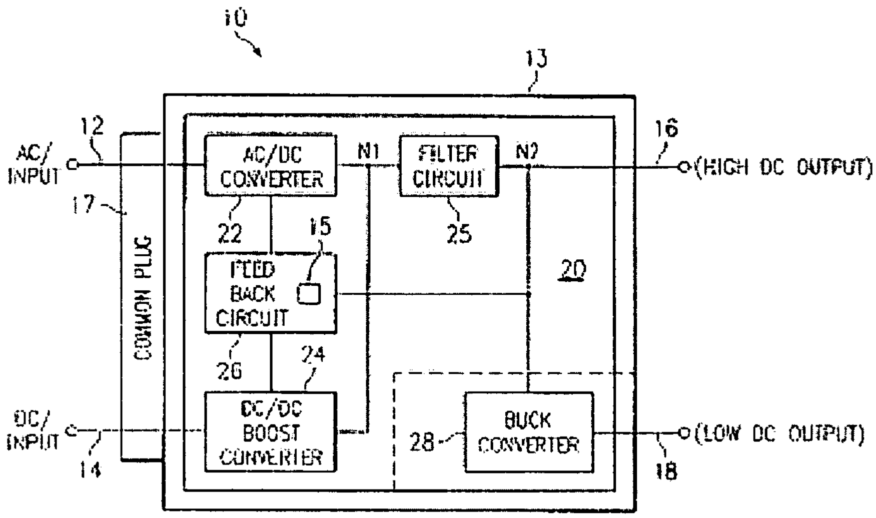


Figure 1A

RU 2274939 C2

RU 2274939 C2

RUSSIAN FEDERATION

FEDERAL SERVICE
FOR INTELLECTUAL PROPERTY,
PATENTS AND TRADEMARKS

(19) RU (11) 2 274 939 (13) C2

(51) Int. Cl.
H02M 1/10 (2006.01)

(12) ABSTRACT OF INVENTION

(21), (22) Application: 2004104345/09, 08.02.2002

(24) Effective date for property rights: 08.02.2002

(30) Priority: 31.10.2001 US 60/335,785

(43) Application published: 27.06.2005

(45) Date of publication: 20.04.2006 Bull. 11

(85) Commencement of national phase: 12.02.2004

(86) PCT application:
US 02/03542 (08.02.2002)

(87) PCT publication:
WO 03/038981 (08.05.2003)

Mail address:
129010, Moskva, ul. B. Spasskaja, 25, str.3,
OOO "Juridicheskaja firma Gorodisskij i Partnery", pat.pov. Ju.D.Kuznetsovu, reg.№ 595

(72) Inventor(s):
MAKDONAL'D Gilbert (US),
SMIT Skott (US)

(73) Proprietor(s):
MOBILITI EhLEKTRONIKS INK. (US)

(54) POWER SUPPLY WITH TWO AC AND DC INPUTS AND PROGRAMMABLE DC OUTPUT USING SECONDARY STEP-DOWN CONVERTER

(57) Abstract:

FIELD: electrical engineering.

SUBSTANCE: proposed power converter 10 with two dc/ac inputs has dual input 12, 14 used to receive both dc and ac input voltage and with selectable dc output 16, as well as second dc input 18. Power converter 10 has power-converter circuit 20 incorporating ac-to-dc converter 22, step-up dc converter 24, feedback circuit 26, filter circuit 25, and dc converter 28. Power converter 10 makes it possible to solve many problems for organizing system operation related to use of complete set of various interface components required for feeding mobile facilities of all kinds from ac or dc power supply. In addition, power converter 10 also has two output-voltage leads 16, 18 enabling power supply to plurality of different mobile facilities from single converter.

EFFECT: enlarged functional capabilities.

25 cl. 6 dwg

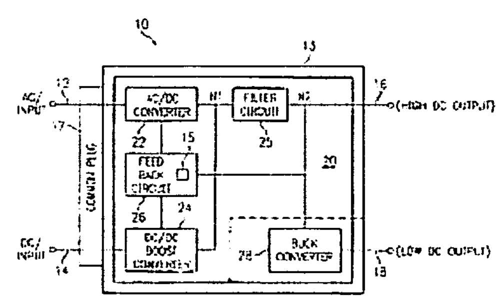


Figure 1A

RU 2274939 C2

RU 2274939 C2

Cross reference to related applications

The present application is related to and claims priority from commonly assigned U.S. Patent application Serial No. 10/005961 filed December 3, 2001, the teachings of which are incorporated herein by reference.

Technical field

The present invention generally relates to the field of power converters and, more particularly, to a dual input AC and DC power converter with programmable DC output.

Background of the invention

As the use of mobile electronic products, such as notebook PCs, PDAs, cellular telephones, and the like, continues to increase, the need for low-cost compact power supplies to power and recharge these products also continues to increase. Most manufacturers of mobile products typically include plug-in power adapters with these mobile products to help facilitate the power supply needs of their customers.

Today's power adapters are typically AC-to-DC or DC-to-DC power converters that are configured to either step up or step down the DC voltage input delivered to the mobile device. With AC-to-DC adapters, for example, users can power most mobile devices by simply plugging the adapter into a simple AC wall outlet commonly found in most homes or offices. Similarly, when only DC input power is available, such as in an automobile or airplane, users can still power their mobile devices by simply using a standard, off-the-shelf DC-to-DC adapter. Normally, both adapters are designed and tailored to provide a regulated DC output voltage, which typically ranges from between 5 VDC to 30 VDC depending on the kind of mobile device being powered.

Although these power adapters conveniently provide direct power and recharging capabilities, users are often required to carry separate adapters to provide power to each individual mobile device. This often means that users have to carry multiple adapters: one for an AC input power source and another for a DC input power source. Moreover, users typically carry multiple adapters to power multiple devices. Thus, by carrying more than one device at a time, users of mobile products are forced to carry more than one bulk power supply adapter.

Accordingly, there exists a need for a power converter that resolves the system management problems associated with carrying all of the different power supply components necessary to power a wide variety of mobile or portable devices. Moreover, such a power converter would advantageously serve the power supply needs of several different mobile devices, as it would supply a filtered and regulated DC output voltage in response to either an AC or DC input voltage. Moreover, by having a power converter with multiple output terminals, users have the ability to provide power simultaneously to several mobile devices with varying power requirements, regardless of whether the input voltage is AC or DC.

Summary of the invention

The present invention achieves technical advantages as a power converter capable of supplying dual DC output voltages derived from either an AC input voltage or a DC input voltage. The power converter can be externally programmable to cover a wide range of voltage

and current combinations suitable for a wide variety of mobile product offerings. Moreover, the power converter resolves the management problems associated with having several different interface components necessary to power a wide variety of mobile products. By having dual output voltage connections, the users of mobile products can simultaneously power multiple mobile devices with varying power specifications.

In one preferred embodiment, the invention is a power converter that has a first circuit adapted to receive an AC input voltage and to provide a first programmable DC output voltage. The power converter includes a second circuit adapted to provide a second programmable DC output voltage in response to a DC input voltage. The power converter also includes a third circuit that, in response to receiving the first and second DC output voltages, generates a selectable DC output voltage at the first output. Moreover, the third circuit generally comprises a feedback circuit and is adapted to interface with a removable programming module. This programming module allows users of the power converter to set the voltage level of the DC output voltage. The power converter also includes a fourth circuit that is coupled to the first output. The fourth circuit provides a second DC output voltage, which is a second output that is independent of and substantially lower than the selectable DC output voltage.

In another embodiment, the invention is a method of generating at least two independently selectable DC output voltages in response to an AC input voltage or a DC input voltage. This method is achieved by converting the AC or DC input voltage to a first programmable DC output voltage at the first output. The conversion is then followed by a receiving act wherein the first DC output voltage is received by a converting circuit. The converting circuit initiates the generation of a second DC output voltage that is independent of and substantially lower than the programmable DC output voltage.

Brief description of the drawings

Advantages of the invention and the specific embodiments will be understood by those of ordinary skill in the art by reference to the following detailed description of preferred embodiments taken in conjunction with the drawings, in which:

Figure 1A shows a block diagram of a dual input AC and DC power converter that has dual DC voltage outputs in accordance with the present invention;

Figure 1B shows an exploded view of the converter with the detachable buck circuit;

Figure 2 shows a schematic diagram of the power converter circuit as illustrated in Figure 1 in accordance with the present invention; and

Figure 3 shows a detailed schematic diagram of a DC-to-DC buck converter circuit in accordance with the present invention.

Detailed descriptions of the preferred embodiment

The numerous innovative teachings of the present applications will be described with particular reference to the presently preferred exemplary embodiments. However, it should be understood that this class of embodiments provides only a few examples of the many advantageous uses and innovative teachings herein. In general, statements made in the specification of the present application do not necessarily delimit any of the various claimed

inventions. Moreover, some statements may apply to some features of the invention, but not to others.

Figure 1A shows a block diagram of the dual input AC-to-DC power converter 10 that has dual programmable DC voltage outputs in accordance with the present invention. Preferably, the dual input AC-to-DC power converter 10 comprises a power converter circuit 20 having an AC-to-DC converter 22, a DC-to-DC booster converter 24, a feedback circuit 26, a filter circuit 25, and a DC-to-DC buck converter 28.

The power converter circuit 20 is seen housed in housing 13 and advantageously provides a first programmable DC output voltage at DC output terminal 16 and a second programmable DC output voltage at terminal 18. Both of these DC output voltages may be generated as a function of both AC and DC input voltages.

In operation, the AC-to-DC converter 22 receives an AC signal via the input terminal 12 and provides a regulated DC output voltage at node N1.

Input terminals 12 and 14 are integrated into the single common connector 17 such that different power cords adapted to receive input power from different sources are received by the common connector 17. For instance, DC power from an airplane or car power source is wired to couple to input 12, and the AC source is wired to couple to input 14. In the selected embodiment, the AC-to-DC converter 22 is adapted to generate a DC output voltage of between 15 VDC and 24 VDC in response to an AC input voltage at terminal 12 ranging between 90 VAC and 265 VAC. Likewise, the DC-to-DC booster converter 24 is adapted to provide a DC output voltage, which is substantially similar to that of converter 22, but which is generated in response to a DC input voltage supplied at input terminal 14. Preferably, DC-to-DC booster converter 24 is adapted to receive a voltage ranging between 11 VDC and 16 VDC. Advantageously, AC-to-DC conversion via AC-to-DC converter 22 allows users of the power converter 10 to power high-power mobile devices, such as a laptop computer, wherever AC input power is available, such as in the home or office, for example. Conversely, the DC-to-DC booster converter 24 of the power converter 10 is capable of powering similar high-power devices by stepping up most low amplitude DC input signals, such as those found in automobile and/or airplane environments.

As shown in Figure 1A, filter circuit 25 has its input tied to the respective outputs of the converter 22 and 24. In a preferred embodiment, the filter circuit is adapted to provide a filtered DC output voltage at the second node, N2, which, thereafter, feeds output terminal 16, at an output power of 75 W, for example.

The single feedback circuit 26 is shown coupled to the output of filter circuit 25 at node N2. In a preferred embodiment, the feedback circuit 26, through a single feedback loop, regulates the voltage level of the filtered DC output voltages generated by both converters 22 and 24. Additionally, the feedback circuit 26 is adapted to receive a removable programming

module that allows mobile device users to provide a selectable DC output voltage at output 16 via node N2. The programming module contains the key 15 comprising a resistor wherein different associated values of the resistor establish different associated DC output voltages at output 16. By allowing users to selectively change the voltage level of the filtered DC output voltage, the power converter 10 may be adapted to power a variety of different mobile electronic devices having different associated power requirements. Moreover, the power converter's 10 programming module may also be adapted to provide the additional function of output current limiting.

The DC-to-DC buck converter 28 has its input coupled at node N2, which provides a second DC output voltage that is then fed to output terminal 18 and has an output power of 10 W, for example. Preferably, buck converter 28 discretely steps down the filtered DC voltage and produces a second DC output voltage at separate output terminal 18. In the selected embodiment, the buck converter 28 steps down the filtered DC output voltage to a range of about 3 VDC and 15 VDC. Advantageously, this second DC output voltage generated by converter 28 is independent of and substantially lower than the DC output voltage at terminal 16. This allows users of the present invention to power not only a high-power peripheral device, such as a laptop computer, but also, a second, low-power peripheral device, such as a cell phone, PDA, and the like. Moreover, the present invention allows for these peripherals to be powered simultaneously by a single converter, regardless of whether the input voltage is AC or DC. The buck converter 28 is physically detachable from the main housing 13 as shown in Figure 1B, allowing for different buck circuits providing different output voltages to be selectively attached to housing 13 and making it possible to tap the DC output voltage from output terminal 18.

Figure 2 shows a schematic diagram of the power converter circuit 20 of the dual input AC-to-DC power converter 10, as depicted in Figure 1, in accordance with an exemplary embodiment of the present invention. As described herein in greater detail, the power converter circuit 20, in a preferred embodiment, contains three separate converters: AC-to-DC power converter 22, DC-to-DC boost converter 24, and DC-to-DC buck converter 28.

AC-to-DC converter

The AC-to-DC power converter 22 includes a true offline switcher, which is configured in a fly-back topology. Full-wave rectification of an AC input signal, which is received at input terminal 12, occurs using a full-wave bridge rectifier BD1 and a filter capacitor C1, which creates a DC voltage bus from which the switcher operates. Inductor L1 offers additional EMI filtering of the AC signal after the signal has been rectified through the full-wave bridge. The AC-to-DC converter 22 also includes a main controller IC1 configured as a current mode pulse-width modulator (PWM). Main controller IC1 is also configured to have a single-ended output with totem pole driver transistors coupled thereto. The AC-to-DC power converter 22 has a main power switch Q1, which drives the main transformer T1. In a preferred embodiment, the transformer T1, Schottky diode D11, and filter capacitors C24 and C25 combine to provide the DC output voltage at node N1.

As noted earlier, filter circuit 25 allows for additional filtering of the DC output voltage derived from node N1. The filter circuit 25 comprises inductor L3, capacitor C26, and transformer NF1. Advantageously, the filter circuit 25 produces a filtered DC output voltage at output 16 having less than 100 mV peak-to-peak noise and ripple.

The feedback circuit 26, through a single feedback loop, is capable of regulating the filtered DC output voltages provided by the converters 22 and 24. The feedback circuit 26 is also adapted to be coupled to a removable programming module having the key 15, comprising resistor R53. As such, the present invention allows users to selectively program the DC output voltage later received at output terminal 16. The feedback circuit 26 includes a photocoupler circuit comprising a pair of photocouplers, PHI andPH3, connected in series (i.e., stacked), each being coupled to the outputs of operational amplifiers IC4-A and IC4-B. Advantageously, these photocouplers are arranged along the feedback loop of the feedback circuit 26. Additionally, the feedback circuit 26 efficiently regulates the filtered DC output voltages generated by both converters 22 and 24 through a single feedback loop. In stacking the photocouplers, the present invention also allows the power converter 10 to maintain proper input/output isolation between respective terminals 12 and 14 and output terminal 16.

Preferably, the converter 22's limiting of the output current is accomplished via integrated circuit IC4A, resistors R33, R37, R38, and R39, and programming resistor R54.

Over voltage protection of AC-to-DC converter 22 is achieved using photocoupler PH2 and Zener diode ZD2. In a preferred embodiment, Zener diode Z2 [*sic*] is set at 25 V such that when in avalanche mode it causes the transistor side of photocoupler PH2 to bias transistor Q1 into the on state. When it is in the on state, transistor Q3 pulls low pin 1 of integrated controller IC1 and pulls the operating duty cycle of the integrated controller towards 0%. This takes the DC output voltage to 0 V. Also, when transistor Q1 is on, transistor Q2 is also forced on, which then forces these two transistors to become latched. If transistors Q1 and Q2 are latched, input power must be recycled in order for the power converter 10 to be turned on again.

DC-to-DC converter

The DC-to-DC converter 24 is configured in a boost topology and utilizes the same kind of integrated controller, IC2, as is used in converter 22. In the DC-to-DC converter 24, transistor Q8 acts as the main power switch, and diode D6, as the main rectifier. Preferably, inductor L2 is adapted to function as a power boost inductor, which is comprised of a toroid core-type inductor. It should be understood that the cathode leads of diodes D11 and D8 are connected, thereby forming an ORed configuration and requiring only one output filter. Advantageously, this eliminates the board space needed for a second set of filter capacitors.

Like the AC-to-DC converter 22, the DC-to-DC converter 24 is also designed to operate at a frequency of around 80 kHz. For the AC-to-DC converter 22, the operating frequency is set by

resistor R13 and capacitor C7. Likewise, the operating frequency of the DC-to-DC converter 24 is set by resistor R28 and capacitor C28.

Filter circuit 25 includes an over-voltage protection circuit comprising the Zener diode ZD2, resistors R23, R24, and R48, transistor Q4, and silicon-controlled rectifier SC1. Zener diode ZD2 sets the over-voltage protection point (OVP) which is preferably set at 25 VDC. Generally, there is no current flowing through resistor R48. If, however, when Zener diode ZD2 begins to conduct current, the drop across R48 is significant enough to bias transistor Q6 on, pulling its collector terminal high, and thereby turning silicon controlled rectifier SC1 on. When silicon control rectifier SC1 is on, it pulls pin 1 of the integrated controller IC2 low. Thus, if pin 1 of integrated controller IC2 is low, the output drivers thereof are forced to operate at a duty cycle of 0%, thereby producing a DC output voltage of 0 V at pin 6. Advantageously, the silicon controlled rectifier SC1 functions as a power latch circuit that requires that input power be recycled in order to turn on the power converter 10 if a voltage above 25 VDC is detected at node N1.

The temperature of the housing 13 of the power converter 10 is monitored using a thermistor NTC3. If, for example, there is a corresponding increase in the temperature of the housing 13, it will result in a decrease in the resistive value of thermistor NTC3, thereby causing transistor Q9 to turn on and pull low pin 1 of integrated circuit IC2 of converter 24. Moreover, this causes the photocoupler PH2 to be sufficiently biased in order to activate a latch circuit comprising transistors Q1 and Q2 that shuts down the power converter 22. In addition, the power converter's 10 thermal protection feature is adapted to operate regardless of whether an AC or DC input voltage is being received at the respective input terminals.

Figure 3 shows a detailed schematic diagram of the DC-to-DC buck converter 28 in accordance with the present invention. The buck converter 28 has an integrated circuit controller IC1, similar to converters 22 and 24, which is adapted to generate an on-time duty cycle to power transistor switch Q1. The operating frequency of controller IC1 is set by capacitor C6, which is coupled between pin 4 of IC1 and ground, and resistor R1, which is coupled between pins 4 and 8. In the selected embodiment, the diode D1 comprises a Schottky diode and functions as a "catch" diode. Inductor L1 is an output power inductor and couples the gate of power transistor Q1 to V_{out}. Figure 3 shows fuse F1 is shown coupled between V_{in} and the drain terminal of power transistor Q1. It advantageously provides current protection to the buck converter 28.

Furthermore, the input V_{in} of the buck converter 28 is coupled to the output of filter circuit 25 at node N2, wherein V_{in} receives the filtered DC output voltage therefrom. In a preferred embodiment, the buck converter 28 provides a second DC output voltage at V_{out}, which is coupled to output terminal 18. Advantageously, the buck converter 28 discretely steps down the filtered DC output voltage and provides a second DC output voltage at output terminal 18, which is independent of and substantially lower than the DC output voltage at output terminal 16. Likewise, the DC output voltage of the buck converter 28 enables users to power low-power peripherals, such as cell phones, PDAs, and similar mobile devices. In the selected embodiment,

the buck converter 28 may also be adapted to provide a DC output voltage at output terminal 18 ranging between 3 VDC and 15 VDC, selectively determined as a function of the chosen value of resistor R1 used in the particular buck converter 28, with a total power delivery of 10 W, for example. As previously mentioned, the buck converter 28 may be housed in a separate, detachable programming module that enables users to selectively program the DC output voltage at terminal 18 as a function of different associated buck converter modules.

Although the invention has been described with respect to specific preferred embodiments, many variations and modifications will become apparent to those skilled in the art upon reading the present application. It is therefore the intention that the appended claims be interpreted as broadly as possible in view of the prior art to include all such variations and modifications.

Claims

1. Power converter (10), containing a first circuit (22) that converts an AC input voltage (12) to a first DC output voltage; a second circuit (24) that converts a DC input voltage (14) to a second DC output voltage; a third circuit (25), to which a first and second DC output voltages are fed, designed with the capability of producing, at its first output (16), a selectable DC output voltage, the selectable DC output voltage being established as a function of a removable program module (15).

2. Power converter according to Claim 1, in which the first circuit and second circuit are designed with the capability of receiving, respectively, an AC input voltage and a DC input voltage from a single common junction (17).

3. Power converter according to Claim 1, in which the removable program module contains a passive component (R53), in which the selectable DC output voltage depends on the value of the passive component.

4. Power converter according to Claim 3, in which the passive component is a resistor (R53).

5. Power converter according to Claim 1, in which the third circuit includes a feedback circuit (26) connected to the first circuit and second circuit, the feedback circuit regulating the first and second DC output voltages formed by the first and second circuits, respectively.

6. Power converter according to Claim 5, in which the feedback circuit contains a single feedback loop.

7. Power converter according to Claim 1, in which the first and second output voltages are essentially equal and go to a common node (N1).

8. Power converter according to Claim 1, additionally containing a fourth circuit (28) connected to the third circuit and designed with the capability of supplying a second DC output voltage of the converter to the second output (18), in which the second DC output voltage of the converter is lower than the selectable DC output voltage.

9. Power converter according to Claim 8, in which a possibility is provided for selective disconnection of the fourth circuit (28) from the rest of the converter (10), which permits connection of different fourth circuits to the converter to produce different values of the second DC output voltage of the converter.

10. Power converter according to Claim 8, in which the fourth circuit contains a buck DC converter that forms the second DC output voltage of the converter.

11. Power converter according to Claim 10, in which the buck DC converter is designed with the capability of forming the second DC output voltage of the converter in the range from 3 to 15 V DC.

12. Power converter according to Claim 8, in which the second DC output voltage of the converter does not depend on the selectable DC output voltage.

13. Power converter according to Claim 8, in which the selectable DC output voltage and the second DC output voltage of the converter are formed by the converter simultaneously.

14. Power converter according to Claim 1, additionally containing a circuit (25) of a filter to filter the first and second DC output voltages and to form a corresponding first and second filtered DC output voltage in the common node (N2).

15. Power converter according to Claim 1, in which the third circuit contains a buck DC converter.

16. Power converter according to Claim 15, in which the second circuit contains a boost DC converter.

17. Power converter according to Claim 16, in which the boost converter and the buck converter are switchable converters operating on the same frequency (80 kHz).

18. Power converter according to Claim 1, in which the first circuit contains a flyback AC to DC converter that serves to form a first DC output voltage in the range from 15 to 24 V DC.

19. Power converter according to Claim 18, in which the second circuit contains a boost DC converter that serves to form the second DC output voltage in the range from 15 to 24 V DC.

20. Power converter according to Claim 1, in which the second circuit is designed with the capability of converting a DC input voltage to a second DC output voltage even in the case of a change in DC input voltage.

21. Power converter according to Claim 1, in which the removable program module limits the output current at the first output.

22. Power converter according to Claim 1, additionally containing a protective circuit (22, 24) that ensures overvoltage protection.

23. Power converter according to Claim 1, in which the first circuit is designed with the capability of receiving an AC input voltage in the range from 90 to 265 V AC.

24. Power converter according to Claim 1, in which the second circuit is designed with the capability of receiving a DC input voltage in the range from 11 to 16 V DC.

25. Power converter according to Claim 1, additionally containing a device (NTC3) that limits heating, which limits the operating temperature of the converter (10).

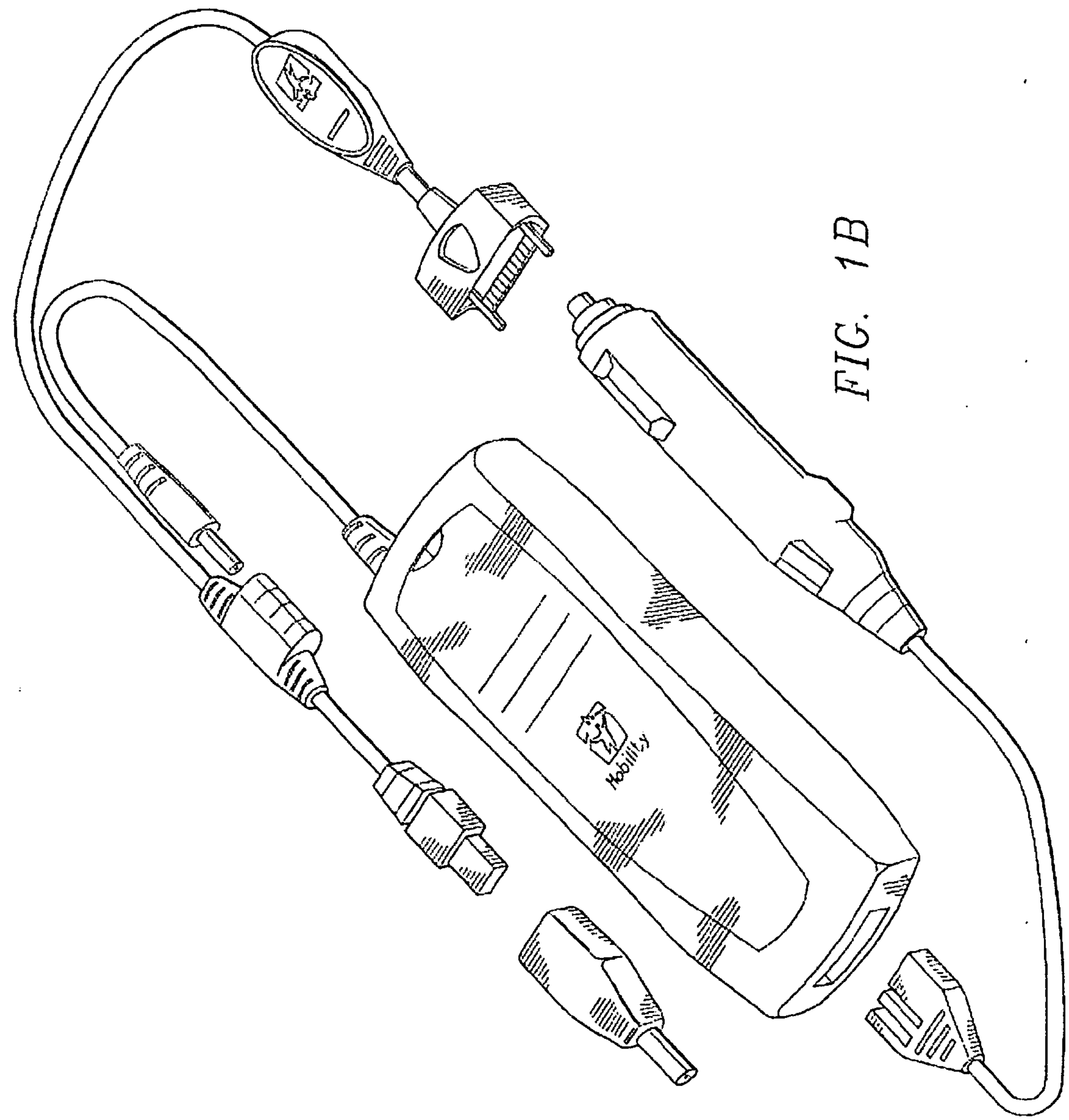


FIG. 1B

FIG. 2A

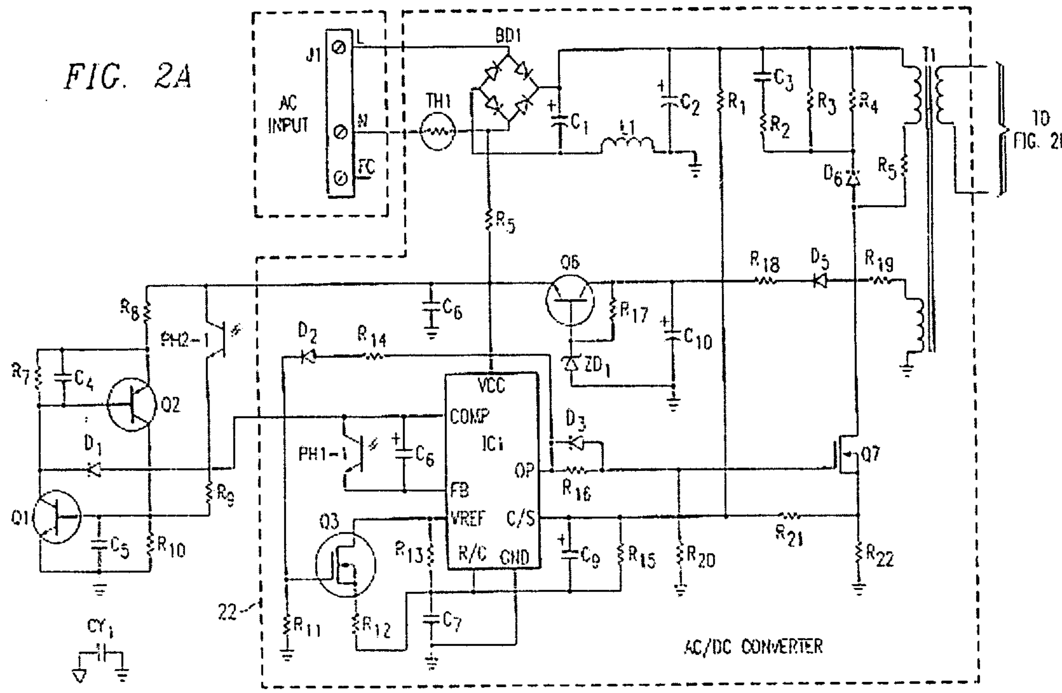
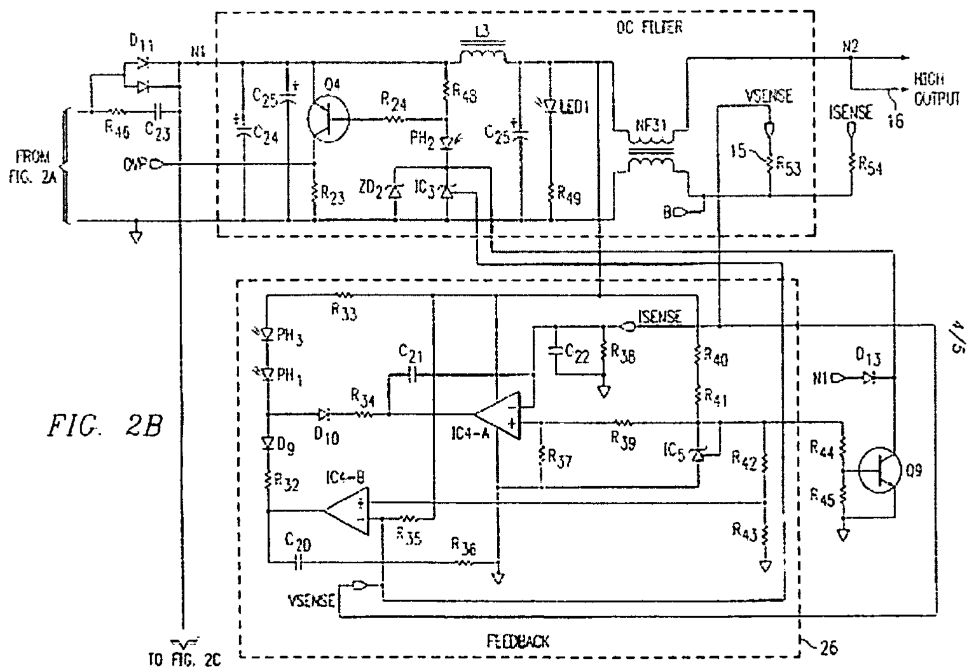

AC INPUT
TO FIG. 2B
AC/DC CONVERTER

FIG. 2B


DC FILTER
FROM FIG. 2A
HIGH OUTPUT
FEEDBACK
TO FIG. 2C

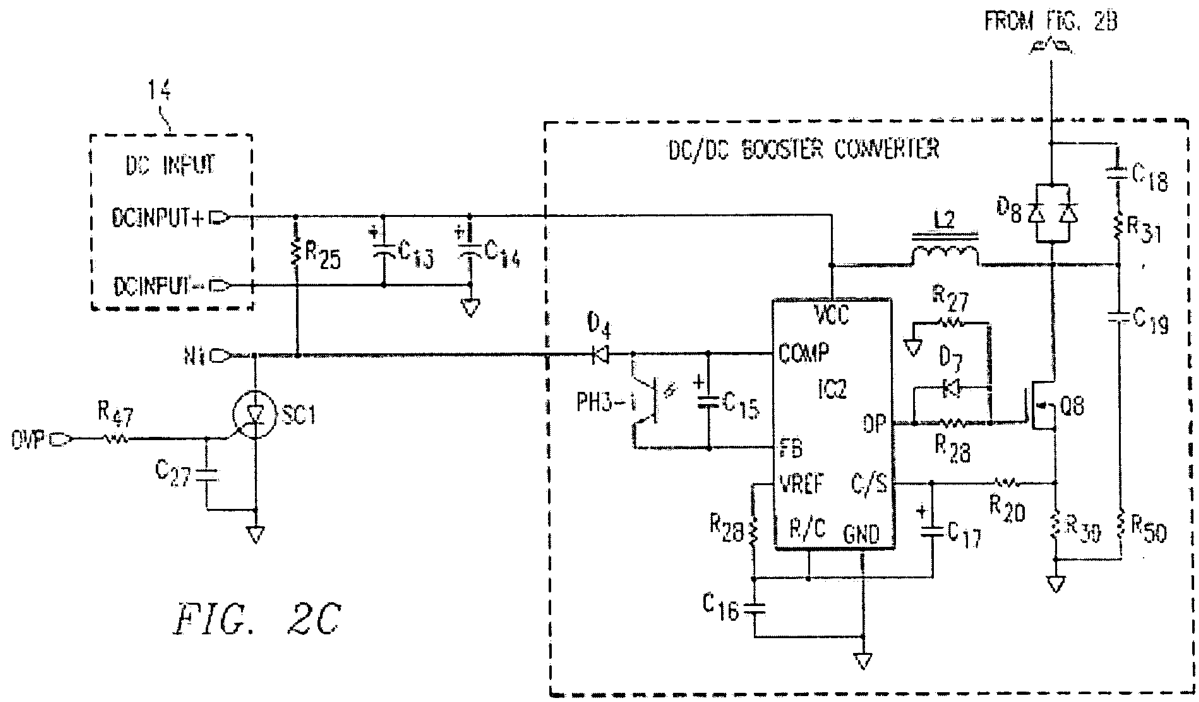

FROM FIG. 2B
14
DC INPUT
DCINPUT+
DCINPUT−
R25
C13
C14
N1
OVP
R47
C27
SC1
DC/DC BOOSTER CONVERTER
D8
C18
R31
L2
C19
D4
PH3−1
C15
VCC
COMP
IC2
FB
VREF
R/C
GND
OP
C/S
R27
D7
Q8
R28
R20
C17
R30
R50
C16

FIG. 2C

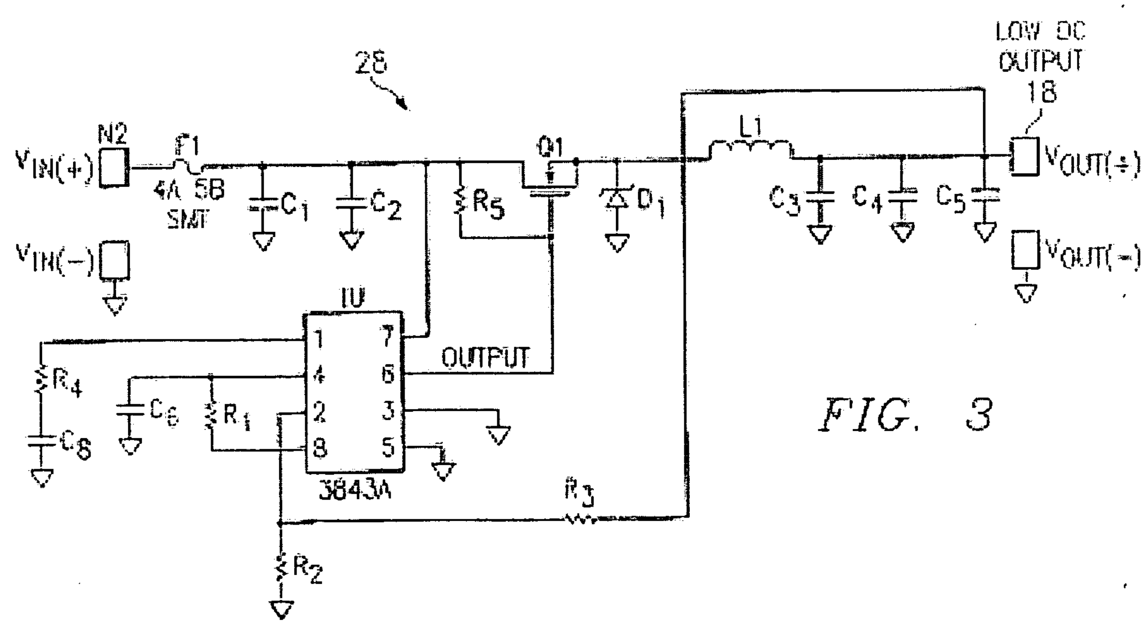

28
LOW DC
OUTPUT
18
N2
F1
4A 5B
SMT
Q1
L1
VIN(+)
VIN(−)
C1
C2
R5
D1
C3
C4
C5
VOUT(+)
VOUT(−)
1U
1
4
2
8
7
6
3
5
3843A
OUTPUT
R4
C8
C6
R1
R3
R2

FIG. 3